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Letters

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Letters

Countering Sokolski

Henry D. Sokolski's article "Mission Impossible" (March/April 2001 *Bulletin*) rightly concludes that, a decade after the introduction of the Counterproliferation Initiative, with which I was privileged to be associated under Defense Secretaries Les Aspin and William Perry, the U.S. Defense Department is still not doing nearly enough to counter proliferation and other asymmetrical threats.

But Sokolski's history of the Counterproliferation Initiative contains two serious errors regarding its purpose. Sokolski imagines that the focus was nuclear responses and "preemptive strikes" on proliferators. In fact, the intent of the program was to give future presidents non-nuclear alternatives, and to provide protection for U.S. forces and allies in wars like Desert Storm, not to conduct preemptive attacks in peacetime.

Sokolski is more accurate when he recounts the pointless lexicographic debate over the word "counterproliferation." He might have noted that President George W. Bush has created an office within his National Security Council that explicitly addresses counterproliferation, so the term seems to have achieved a lasting significance.

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The integral fast reactor could do it

The sane management of nuclear weapons and nuclear power requires a clear separation of fact from myth. "Magical Thinking—Another Go at Transmutation," by Arjun Makhijani et al. in the March/April issue of the *Bulletin,* makes a case against the practicality of transmutation that does not withstand scrutiny.

In their zeal to paint nuclear power in a bad light, the authors gloss over the characteristics and capabilities of metal-fueled, liquid-sodium-cooled fast reactors, which are technologically, if not politically, as close to an ideal solution to the transmutation problem as one could hope to get.

A number of transmutation methods have been proposed, and there are very significant differences between them in efficiency, safety, completeness, economics, and proliferation resistance—distinctions that were frequently blurred in Makhijani's article.

One specific transmutation technology, the Integral Fast Reactor (IFR), illustrates the current state of the art. The reactor uses metallic fuel, with liquid sodium as the coolant. A reprocessing unit would reside at the same site (hence the name "integral")—a very important feature.

The IFR installation could accept as fuel all fissionable isotopes (including uranium, plutonium, and the higher actinides), and would consume them so efficiently that the waste stream would be virtually free of them—they would be shipped into the plant but never come out.

This would greatly reduce waste repository requirements, although the need for a repository would not be completely eliminated because remaining radioactive fission products must be sequestered for a few hundred years.

The authors' generic use of the term "reprocessing" clouds the issue. The IFR's pyroprocessing technology should cause the blanket U.S. policy against reprocessing to be revised. That policy was formulated when the only practical reprocessing technology was the PUREX (Plutonium Uranium Extraction) method, developed specifically to produce plutonium of the chemical purity needed for weapons. Pyroprocessing does not and cannot produce weapon-grade plutonium. The goal of the U.S. no-reprocessing policy is to render plutonium unavailable for weapons, which is exactly what the IFR does.

Nonetheless, any reactor could be commandeered and modified to produce weapons plutonium, and all reactors must be subject to international inspection. But the IFR would present no special challenges to inspectors. In fact, it would make their job easier because the plutonium from the special fuel elements could not be extracted at an on-site reprocessing facility—the elements would have to be shipped to a covert PUREX plant.

IFR technology has surprising capabilities. If from now on the only power plants to be built were IFRs or their equivalent, after a few decades all current global excess plutonium would have been consumed and all existing thermal reactors and fossil-fueled plants could be shut down.

All the plutonium (except for supplies withheld for weapons) would be in reactor cores and in collocated reprocessing streams, where it would

be inaccessible—protected by radioactive, chemical, mechanical, and procedural barriers.

Commerce in plutonium would have been nearly eliminated. Plutonium would rarely be shipped from one site to another—it would stay at a reactor until it had been consumed. The only fuel-type material to enter an operating facility would be uranium (any isotopic composition would do), introduced as needed to replace the actinide atoms that had been consumed.

Only rarely would plutonium have to be transported. When a facility was closed down and decommissioned, the remains of its last core loading would need to be shipped to another operating facility for incorporation into its fuel, or to a new facility to provide part of its startup loading.

With electric-powered motor vehicles and no fossil-fueled power plants, man-caused emissions of carbon dioxide would have been reduced far below the Kyoto goals.

The volume of high-level waste would be small, and (in a rational world) an assured geological sequestration time of 500 years would make disposal far cheaper than the much longer-term schemes required today. No geological deposits of plutonium would be created.

Enrichment of uranium would have permanently ceased. Any enrichment operation would constitute *prima facie* evidence of intent to proliferate, as would a PUREX reprocessing facility.

Until the uranium currently on hand had been used up—which could take centuries—no milling of uranium nor mining of uranium or coal would be needed.

A project to demonstrate the practicality of the IFR concept was in its final stages in 1994, when, for ideological reasons, the program was aborted because it would have "legitimize[d] the reprocessing of spent nuclear fuel."

A 1996 National Academy of Sciences study predicted that, were IFR transmutation to be used, "The additional cost of generating wholesale electricity could increase from 2 to 7 percent." That's tantamount to predicting that IFRs would be economically competitive.

George S. Stanford
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* * * *

Arjun Makhijani responds:
George Stanford's enthusiasm for the Integral Fast Reactor (IFR) harks back to the days of "too cheap to meter," when the nuclear establishment promised far more than it could deliver. But Stanford's proposal for waste management is impractical.

Despite five decades of development and more than $20 billion spent worldwide, sodium-cooled reactors have not been technically mastered, much less commercialized. The operating record of these reactors is very uneven, with major problems afflict-

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Updates

To irradiate, or not to irradiate
In the March/April 2000 issue, the *Bulletin* reported that after years of debate, the Food & Drug Administration had finally issued regulations allowing the irradiation of red meat ("Ready, Set, Irradiate"). But the food industry remained reluctant to zap meat products, in part because of consumer doubts. In April, however, the Bush administration appeared to give food irradiators a boost: In place of costly Clinton-era regulations mandating salmonella tests for ground beef served in federally funded school lunch programs, the Agriculture Department would allow schools to serve irradiated beef. But on April 6, a day after the new policy was reported in the *New York Times*, Agriculture Secretary Ann Veneman rescinded the changes, removed a press release about them from Agriculture's web site, and admonished her underlings for making policy behind her back.

Bobbing for nukes
In late 1997, Russian nuclear officials proposed building a floating nuclear power plant to supply power to the Siberian city of Pevek ("Neighborly Concern," January/February 1998 *Bulletin*). Although the Pevek plan was eventually dropped, the Russian Nuclear Power Ministry announced in March that the blueprints for the Pevek reactor would be used to build a plant for the northwestern town of Severodvinsk (*Moscow Times*, March 15). A similar idea was recently floated by Cong. Joe Barton, a Texas Republican, who proposed harnessing the energy from nuclear-powered U.S. Navy ships and subs to help alleviate California's energy crisis (*San Diego Union-Tribune*, March 28).

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in recent years, including the NRO. A preferable course would be to follow the recommendation that Senator Kerrey himself made in 1996, when he suggested to the Senate Select Committee on Intelligence "that not only the top line [of the NRO budget], but several other lines of the budget, not only could but should [be disclosed] for the purpose of giving the taxpayer-citizens confidence that their money is being well spent."

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ing even the newest. France's Superphénix, the world's largest sodium-cooled reactor, was permanently closed in 1998 after 14 years of sporadic operation. Monju in Japan, the newest reactor, had a sodium fire only 20 months after it was commissioned in 1994. It remains closed.

As for IFRs, the 1996 National Academy of Sciences (NAS) study cited by Stanford concluded that there were several safety issues that remain to be resolved and that using advanced sodium-cooled reactors for transmutation "would require substantial development, testing, and large-scale demonstration under Nuclear Regulatory Commission safety review and licensing before one could proceed with confidence."

Even if all the technical problems posed by IFRs were to be solved, the costs of using this technology would be prohibitive. In the United States alone, IFRs would have to fission roughly 80,000 metric tons of heavy metal (about 99 percent of which is uranium). To transmute this amount of heavy metal over 40 years would require the building of about 2,000 IFRs of 1,000-megawatts capacity each. To manage the worldwide stock of spent fuel (both current and projected) in this way would require roughly four times as many reactors. Even assuming that one IFR reactor was brought on line a week, it would take 150 years to build them.

The NAS study also expressed skepticism that the reprocessing technology associated with the IFR could be made as economical as its proponents claim. The IFR requirement of collocating the reprocessing element with the reactor would result in even higher costs because of the small scale of collocated plants.

NAS's conclusion that there would be a 2 to 7 percent increase in electricity costs was based on low reactor costs and transmutation costs that were "likely to be no less than $50 billion and easily could be over $100 billion" for 600 metric tons of transuranics only. If the cost of reprocessing uranium is added, the total cost would increase to $300 billion–$900 billion for the United States alone. It is easy to see why no current transmutation scheme seriously proposes to transmute all the uranium in spent fuel.

Stanford fails to address the main proliferation concern of IFRs, which require an electrometallurgical separation plant. Although the impure plutonium that results from this reprocessing technique is not weapons grade, it is weapons-usable. Current nuclear weapons states would not use the material for weapons, but states with no other way of separating weapons-usable material could find electrometallurgical processing quite attractive.

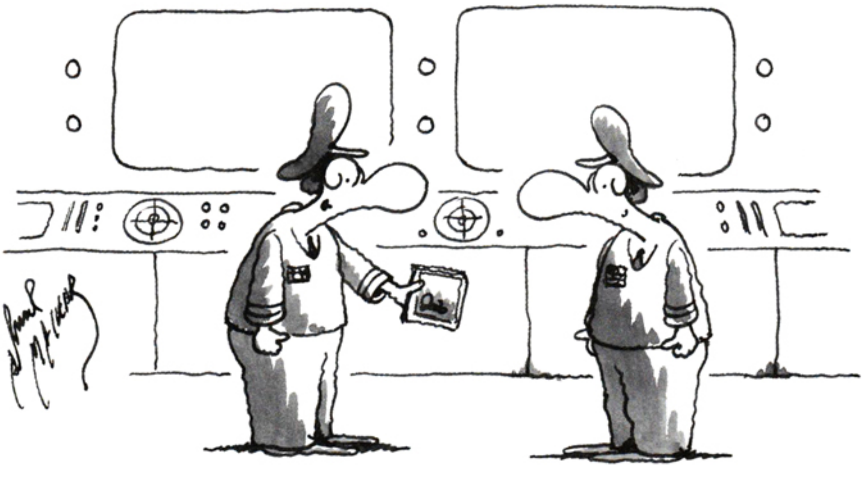
Finally, terminology. We use the term "reprocessing" as a generic word for separations technology, and terms such as "electrometallurgical processing" when it is necessary to refer to specific characteristics of the technology. This is common practice—as followed by the 1996 NAS study.

It may be difficult for fans of sodium-cooled reactors to give up their dreams of a plutonium economy. But they should stop pretending that schemes like the IFR are going to solve the knotty problem of nuclear waste that the first round of nuclear energy adventures has created.

No easy out

In his article "Setting the Scene" (March/April 2001), Bret Lortie writes that "even the CTBT [Comprehensive Test Ban Treaty] allows a signatory to resume testing if it feels its stockpile is unreliable."

For the record, the CTBT does not offer signatories this option, although the United States has "reserved" the right to do so. The actual treaty has no easy exit, withdrawal, or amendment options.



"Want to see some satellite pictures from my vacation?"

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A party to the CTBT can only withdraw by giving six months advance notice, and that notice must be accompanied by an explanation of the extraordinary event or events that it regards as jeopardizing its supreme interests.

However, according to the Vienna Convention on the Law of Treaties, a country can only withdraw from a treaty if the reason is related to the treaty's purpose. Since the purpose of the CTBT is to ban nuclear testing, the condition of the U.S. stockpile is irrelevant. No country can legally withdraw from the CTBT because it feels its nuclear weapons have become unreliable.

The purpose of the CTBT is to ban all nuclear testing, and when it enters into force, it will prohibit all nuclear explosions in all environments for all time.

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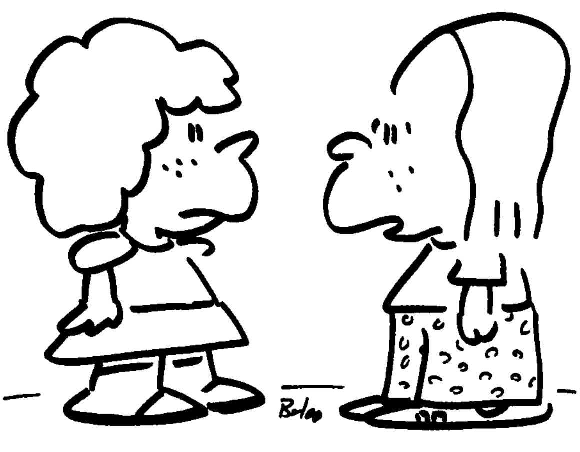
No time for NMD

The Bush administration is intent on building an anti-ballistic missile system. But that system will not protect the United States from nuclear weapons. Here's why:



"Our family is a democracy, but my little brother is a vast right-wing conspiracy."

In order to protect any target, a defense system must be 100 percent effective at stopping every warhead that is aimed at it. If only one warhead strikes, the result is devastating: The temperature at the sun's core reaches 27 million degrees Fahrenheit, but the temperature at the center of a blast of a 1-megaton bomb (common in both U.S. and Russian arsenals) is four times hotter. Wind speeds a mile and a half from ground zero exceed 2,000 miles per hour. Destruction and death from the blast alone is total within 5 miles of the center, severe within 10 miles. Beyond 10 miles, fire and radiation take a heavy toll. Nuclear weapons unleash energies that are indescribable on a human scale.

No defense is likely to be anywhere near 100 percent effective. It is very difficult to shoot down an incoming missile warhead with an ABM. Ballistic missile warheads reach altitudes of more than 600 nautical miles (more than twice the height at which the space shuttle orbits), are very small (U.S. warheads are typically about 6 feet long and 18 inches wide at the base and resemble a large artillery shell), and travel 10 times faster than a rifle bullet (a typical re-entering ballistic missile travels at about 15,000 miles per hour). *To successfully intercept a warhead, the kill vehicle must travel through the same one-and-a-half-foot-wide area of space during the same three-thousandths of a second.*

Tests to date have not been encouraging. In 10 tries against intercontinental ballistic missiles (ICBMs) since 1984, ABMs made successful intercepts only three times, for a 30 percent success rate. And that was under ideal test conditions—defenders knew everything there was to know about the incoming warheads, the time and place of launch, flight trajectory, and radar signature—information that would not be available in the real world.

Suppose, however, that despite all these difficulties, the problem of hitting small and extremely fast-moving targets could be mastered, and the warhead interception rate seemed to be 100 percent. Would that be a clear signal that it was time to build a national missile defense (NMD)?

Unfortunately, the answer is no. In practice, the use of countermeasures would cause the effectiveness rate to plummet. For example, a single ICBM might carry 10 warheads and as many as 200 decoys. These decoys are virtually indistinguishable from the warheads. They will fool both ground- and space-based radars and infrared sensors aboard the interceptors. So far, none of the interceptors tested have been able to distinguish decoys from actual warheads. Decoys are also relatively easy to make and can overwhelm by saturation alone. For example, to guarantee a 100 percent kill rate, the United States might need 210 interceptors to intercept 10 warheads.

As if this were not enough, the warheads could be placed inside inflatable balloons, which would be released and inflated during the coast phase of the re-entry vehicle's trajectory. The balloons, which can be covered by metallic foil making them impervious to both heat and radar detection, may or may not contain a warhead. The defense system might be able to detect 210 balloons, but it wouldn't be able to tell which (if any) contained warheads. A kill vehicle might hit a balloon (which could be quite large), yet still miss the relatively small warhead inside. A single ICBM could hurl a "cloud" of hundreds of balloons, decoys, and warheads.

Other methods of fooling the system include metallic chaff that could be dispensed to blind radars. Some

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decoys could carry small, active transponders, which send out false echoes, further confusing the radars. Warheads could also be coated with radar-absorbing materials. Special heat-absorbing aerosols as well as flares could further confuse infrared sensors. Warheads could also be jacketed in containers of Freon, virtually eliminating the heat signature. Compared to the enormous difficulty in design and construction of nuclear weapons and the rockets that carry them, all of these countermeasures are relatively easy to implement. U.S., British, and Russian ICBMs have been equipped with countermeasures for more than a decade.

The Russians have a missile right now, the SS-27, or Topol-M, which carries a "MARV"—a maneuverable reentry vehicle that moves in unpredictable ways to avoid interception.

Then there are nuclear effects. A single nuclear device, detonated at high altitude, would generate a huge, expanding cloud of ionized gas, blocking electromagnetic radiation and virtually blinding radar for 30 minutes. A nuclear explosion would also emit an electromagnetic pulse that disables microelectronic systems. A 1-megaton bomb detonated in outer space could disable an unprotected satellite at a range of 15,000 miles. Hardening satellites and other electronic devices against these effects is only moderately effective.

The electromagnetic pulse distorts radio communications, disables both ground- and space-based radar, and blinds interceptors' infrared sensors. Consequently, even the most capable ABM system so far imagined would be instant junk once nuclear weapons are detonated in outer space. No proposed ABM system carries its own nuclear devices to destroy incoming warheads; nuclear explosions would disable the system. And there is nothing to prevent the enemy from deliberately detonating a few bombs in space during an attack, or alternately, salvage-fusing nuclear warheads (rigging them to detonate on impact). In either case, once one warhead was intercepted, no more interceptions could take place.

Not all threats come in the form of an ICBM. Even if all the above-mentioned difficulties were overcome, the United States would still not be protected. An NMD system operating above the atmosphere would be useless against cruise missiles, which skim along the earth's surface at 200 feet or less. Cruise missiles can be delivered from submarines, surface ships, and planes.

Even if cruise missiles could be intercepted, enemies could deploy large nuclear mines off the U.S. coast. Even more ominously, some nuclear devices are small enough to be delivered in a suitcase.

Suppose some as-yet-unimagined defense could be constructed against all these threats, would the United States be protected then? Sorry, the answer is still no.

Even a nation of relatively moderate industrial capacity could construct a "Doomsday" device à la *Dr. Strangelove*, by modifying enough nuclear bombs with metal cobalt to poison the world's atmosphere. Of course, against that type of attack, all missile defenses would be useless.

The point is, of course, that there are no effective defenses against nuclear weapons. As Richard Nixon concluded during his presidency, "Every instinct I have motivates me to protect the United States, but it is impossible to do so, and we must all learn to live with that fact."

Some argue that now is the time to unilaterally break the ABM Treaty. Some think any NMD system, no matter how inept and ineffectual, would be better than none at all. But building an ineffective ABM system will be worse if we believe it works. Political leaders will be tempted to take actions they would otherwise regard as too dangerous. Better to have no defense at all than one that leads us to a false sense of security.

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Leonard T. Roth
Tampa, Florida

Correction

As reader Gordon Burck points out, the photo caption accompanying Aluf Benn's article, "Israel's Decision Time," (March/April 2001 *Bulletin*), stated that Israel signed the Chemical Weapons Convention in 1983. The correct date, as indicated in the article, is 1993.